DOCUMENT RESUME

ED 305 924 IR 013 793

AUTHOR Lockheed, Marlaine E.; And Others
TITLE Student Use of Applications Software.
INSTITUTION Educational Technology Center, Cambridge, MA.
SPONS AGENCY Office of Educational Research and Improvement (ED), Washington, DC.
REPORT NO ETC-TR-85-3
PUB DATE Jan 85
NOTE 90p.
PUB TYPE Reports - Research/Technical (143)

EDRS PRICE MF01/PC04 Plus Postage.
DESCRIPTORS *Computer Literacy; Computer Software; *Curriculum Development; Difficulty Level; Elementary Secondary Education; Questionnaires; School Surveys; *Teacher Attitudes; *Teaching Skills; Use Studies

ABSTRACT

This report studies the learning and use of computer applications programs--i.e., word processing programs, database management programs, and spreadsheets--in elementary and secondary school computer literacy courses. This study was designed to identify teachers' pedagogical assumptions and expectations underlying the use of applications software in the school classroom, and to specify targets of difficulties, especially recurrent difficulties encountered by students of even the most experienced teachers. Activities include a literature search, a questionnaire survey of elementary and secondary school teachers in 18 school districts, and classroom observations of 11 teachers learning to use Applewriter II, PFS File, and Visicalc. A tentative list of the targets of difficulties groups the problems in six areas: (1) keyboarding; (2) computer concepts; (3) operations within specific programs; (4) information management; (5) attitudes and beliefs; and (6) organizational constraints. Three appendixes provide cross tabulations of questionnaire responses by grade level. A thesaurus of keywords describing targets of difficulty for applications software and a sample database of difficulties arranged in outline format are included. (28 references) (EW)

****
* Reproductions supplied by EDRS are the best that can be made *
* from the original document. *
****

85-3

IR

U.S. DEPARTMENT OF EDUCATION
Office of Educational Research and Improvement
EDUCATIONAL RESOURCES INFORMATION CENTER (ERIC)

X This document has been reproduced as received from the person or organization originating it.

☐ Minor changes have been made to improve reproduction quality.

• Points of view or opinions stated in this document do not necessarily represent official OERI position or policy.

ED305924

STUDENT USE OF APPLICATIONS SOFTWARE

Technical Report

January 1985

Educational Technology Center
Harvard Graduate School of Education
337 Gutman Library Appian Way Cambridge MA02138

IR013793

Student Use of Applications Software

Technical Report
January 1985

Prepared by
Marlaine E. Lockheed
Joan P. Gulovsen
Donald Morrison

Group Members

Elizabeth Bjork, Education Collaborative for Greater Boston
Charlotte Fogarty, Ware [Mass.] Public Schools
Joan Gulovsen, Harvard Graduate School of Education
Marlaine Lockheed, Educational Testing Service
Jane Manzelli, Brookline [Mass.] Public Schools
Carolee Matsumoto, Concord [Mass.] Public Schools
Donald Morrison, Harvard Graduate School of Education
Deborah Ross, Cambridge [Mass.] Public Schools
Kim Storey, WGBH
Joseph Walters, Harvard Graduate School of Education

Acknowledgements

Members of the group would like to thank our many school colleagues for their enthusiastic support of the research reported here. We are indebted to the seventy-one teachers who responded to our questionnaire survey, and to the Edco Computer Committee Representatives who helped us circulate it.

We would also like to thank Donald Lombardi, and the teachers who participated in his Application Software Curriculum Project. Their willingness to let us observe their efforts to learn some very difficult programs provided us with an important opportunity for data collection. In addition, we need to offer our special thanks to the seven anonymous teachers who took time away from their busy schedules to be interviewed by the research assistants.

Finally, we wish to thank Decker Walker, of Stanford University, and Peter Dublin, of Intentional Educations for their helpful comments on an earlier version of this report. Needless to say, the authors take full responsibility for any remaining deficiencies.

Contents

1.0 Introduction 3

2.0 Methods 12

3.0 Results 15

4.0 Discussion 32

5.0 Future plans 33

References 35

Bibliography 36

Appendix A: Crosstabulation of Questionnaire Responses..38

Appendix B: Thesaurus of terms 72

Appendix C: Sample data base 80

1.0. Introduction

1.1 Why study the use of applications software?

Computer literacy courses at the elementary and secondary level typically provide an overview of the architecture and operating principles of computer software and hardware, an introduction to a programming language, and some discussion of social issues related to computing. Recently these courses have begun to devote attention to instruction in the use of such applications programs as word processing programs, file and data base management programs and spreadsheets. Other popular applications programs facilitate instrumentation (data collection via computer), telecommunications, graphics production, music generation, modeling, and simulation. In the long run, the teaching of these programs may have a more profound impact on educational and occupational skills than the other facets of computer literacy courses.

We are interested in studying the learning and use of applications programs for four reasons: (1) competency at using a computer is gaining increasing acceptance as a high school graduation requirement; (2) competency at using a computer includes using applications programs; (3) introductory courses that teach the use of applications

programs may be more useful and attractive to students and teachers than courses that stress programming; and (4) learning applications may be an important way of learning general concepts about computers, may have consequences for the acquisition of general problem-solving skills and may fundamentally change the ways in which certain curricula are taught and learned.

1.1.1 Mandates

Twenty states and the District of Columbia now require schools to offer their students exposure to computers, and two more states have legislation pending (Barbour, 1984). Several national panels and foundations have recently recommended that students acquire competence at using computers and other technologies. For example, the National Science Foundation recommends instruction for all students designed to give them "experience in using the computer as a tool, which should include experiences in the use of standard application software such as word processing systems and filing systems" (National Science Board Commission on Precollege Education in Mathematics, Science and Technology, 1983, p. 100).

Also, noting that "the computer is being used increasingly by students and their teachers as an instrument to receive, organize, store, analyze and interpret information, as well as a medium for the communication of that information", the College Board recommends that students entering college should have "some ability to use the computer and appropriate software for self-instruction; collection

and retrieval of information; word processing; modeling, simulations and decision making; and problem solving -- both through the use of existing programs and through experience with developing one's own programs" (Academic Preparation for College, 1983, p.12).

The Carnegie Commission on the Advancement of Teaching recommends that "all students study technology" and that schools should relate computer resources to their educational objectives. Specifically, all students should "learn about computers; learn with computers; and, as an ultimate goal, learn from computers" (Boyer, 1983, p. 110).

1.1.2 Computer-using students.

These recommendations emphasize the concept of the "computer literate" student. As defined by a national panel of computer scientists and computer education experts for the National Center for Education Statistics, this is a student who has the "ability to use and instruct computers to aid in learning, solving problems, and managing information; a knowledge of functions, applications, capabilities, limitations, and social implications of computers and related technology; and the understanding needed to learn and evaluate new applications and social issues as they arise" (Lockheed, Hunter & Anderson, 1983, p. 8-9).

Computer literacy course objectives developed by such groups as the Minnesota Educational Computing Consortium (1981), the Alexandria

(Virginia) Public Schools (1983), the Department of Defense Dependents Schools (1982), the International Council for Computers in Education (1982), and the State of California (1983) all stress the student as the user of computers and recognize that using computers includes using applications programs written by others, as well as writing one's own programs. In its fourth annual survey Electronic Learning indicates that the trend in computer literacy courses is towards focusing on applications-type programs at the secondary level (Barbour, 1984). The state of Texas, moreover, has required that computer literacy textbooks be accompanied by word processing, database, and spreadsheet software.

1.1.3 General appeal.

According to the National Center for Education Statistics, most large computers in schools are used for teaching programming languages, and most microcomputers are used for "computer literacy" classes (Wright, 1983). Although the course descriptions of computer literacy classes tend to include a number of topics, the most frequently taught subject is BASIC programming (Becker, 1982). Researchers have noted that, while a vast majority of young people believe that computers will be useful to them for their future work, and indicate that they intend to take computer courses in college, actual enrollments in computer courses differ according to the student's gender, ethnicity and social class (Gallup, 1983; Lockheed, Nielsen & Stone, 1983; Miura & Hess, 1983; Fetler, 1983). A possible explanation for these differences may be the association

of computing with mathematics and with specific programming languages. Courses that stress applications programs, however, would not appear to have this relationship and might have a broader appeal. There is evidence, for example, that high school girls enrolled in introductory computing classes are more likely than their male classmates to indicate an interest in future computer courses that would teach word processing or business or research applications (Lockheed, Nielsen & Stone, 1983).

1.1.4 Cognitive and curricular consequences.

In many cases, applications software was originally developed for business rather than educational uses, and was aimed at adults, rather than children, as users. (Notable exceptions include Bank Street Writer, Quill, and Notebook, which were designed with children in mind.) Because applications software is, almost by definition, not intentionally educational in nature, it is in many ways fundamentally different from other kinds of software used in the classroom. One critical difference between applications software and other educational software is that there are no specific learning objectives. That is, whereas typical drill-and-practice CAI software is designed to teach a particular set of information, such as multiplication facts, applications software is not designed to teach anything.

This is not to say, however, that applications software cannot be used to teach a large set of problems, concepts, and skills. For example, English teachers are using such word processing programs

as Bank Street Writer and Quill to teach writing, and science teachers are using such data base managers as PFS File or Notebook to teach about classification, hypothesis development, data gathering, and hypothesis testing.

Applications software may also be put to a wide variety of other uses. Word processors may be used to write poetry, to generate form letters, to compose class newsletters, to prepare posters, to write up science experiments, or to assemble cookbooks. File managers may be used to maintain mailing lists, to develop knowledge bases about particular topics (for example, whales, European countries, butterflies), or to keep track of foreign language verb endings. Integrated packages such as Appleworks or Lotus 1-2-3 may be used to record and analyze data from laboratory experiments in science or from a social studies questionnaire and to present the results in a written report which includes graphic representations of the data.

Perhaps more important still, in the process of using application programs, students may learn to perceive "real-world" problems as involving complex sets of relationships which they can capture using the model of the software. This in itself would be a significant cognitive achievement.

Because applications software rarely consists of "turnkey" operations, such uses of applications software could also require changes in the curriculum. For example, using a word processor requires an

understanding of fundamental computer concepts, and a knowledge of a large number of different commands and operations. These include commands involving cursor movement, saving and loading files, switching modes, and deleting unwanted characters from the screen. Users need to know about how computers themselves operate, at both the program level and the operating system level. Hardware expertise may also be required. Where different application software programs are used in combination, requisite technical skills may become even more complex, particularly where compatibility problems may be involved.

In addition to these technical skills, successful use of a given program may depend on the user having adequate conceptual models of the program and the tasks that the program is designed to carry out. For example, in order to successfully perform "block moves" with a word processor, one must know both that word processors are in fact capable of manipulating text in this way, and also how a block move is accomplished with the program in question. At another level, it is also necessary to conceive of written texts as consisting of potentially movable sections.

To give another example, the use of a data base management system demands an ability to distinguish between levels of a hierarchical classification and to select appropriate units of analysis. This ability, which is not specific to the use of computer software, is demanded in addition to the knowledge that data base systems distinguish between files, records and categories. All of this suggests the

need for substantial curricular revision, which may be more effective when embedded in the regular content areas of the curriculum than when presented in stand-alone "computer literacy" courses.

1.2. Conditions for implementation.

Although applications software may have rich and profound educational potential, the undefined nature of this potential may make it relatively difficult for teachers to integrate these tools into the ongoing curriculum. Indeed, successful use of applications software may require more originality on the part of teachers than is required for traditional types of software, such as CAI packages, particularly until specific curricular materials are available that utilize applications software. Such materials as knowledge bases for use with specific file management and data base programs are under development by commerical publishers.

Researchers studying the successful adoption of innovation in schools have pointed out that innovations are implemented in the classroom when there is administrative support and coordination (Berman & McLaughlin, 1980; Fullan, 1982), when there is collegial interaction regarding the innovation (Cohen & Intilli, 1981), and when innovators receive feedback regarding their efforts. These conditions almost certainly vary in schools in which applications software are introduced, and may strongly affect their adoption and implementation.

1.3. Research objectives.

Although there is growing interest in teaching applications programs and in integrating computer applications into math, science, language arts and social studies classes (Hunter, 1983), we have little information about recurrent areas of difficulty, because -- at present -- relatively few teachers and students have actually used these tools in classrooms. Historically computers were used for computer-assisted instruction (CAI) in elementary schools (Jamison, Suppes, & Wells, 1974), and for programming in secondary schools (Computers in Public Education Study, 1979). Applications software -- to the extent that they were available -- were limited to packaged data analysis programs, such as BMD or SPSS, that were used in higher education. Only with the advent of powerful microcomputers did relatively low-cost applications software become available to the classroom teacher.

In our present research activities, we wish to address the following questions:

(1) How and to what extent are teachers now using applications programs?

(2) In using applications programs, what difficulties arise for either students or teachers?

(3) What opportunities for using applications software are there in the elementary and secondary curriculum?

(4) When teachers use applications programs, how does this

use affect the existing curriculum, and what is the nature of that effect?

2. Methods.

2.1. Research approach.

The nature of the research conducted by this group differs from that conducted by the other ETC research groups, because of the fundamental difference between what is known in the other areas and what is known about the use of applications programs. A major purpose of this research was to identify targets of difficulty associated with the use of applications programs; only after they have been identified can we address the question of how technology can be used to solve them. Our research approach included three broadly defined stages, the first of which serves as the basis for this report:

(1) Identification of teachers' underlying assumptions and expectations. Because we did not have clearly defined "targets of difficulty", we needed to ask general questions about the pedagogical assumptions and expectations underlying the use of applications software in the school classroom.

In this stage of the research, we have worked closely with a few teachers who are currently using applications software in their classrooms; the aim of this research approach was to determine

where and under what conditions applications software is being used, how it is integrated into the curriculum, and to observe what problems arise in connection with its use. We have undertaken informal observations, conducted teacher interviews, and developed a tentative list of difficulties.

(2) Specifying targets of difficulty. During the second phase of the research, we plan to validate the list of difficulties through observations in a variety of classroom settings and analyze data gathered from interviews and classroom observations, with a view towards identifying recurrent difficulties encountered by students of even the most experienced teachers. A taxonomy of difficulties will be developed and field tested.

(3) Designing curriculum innovations. During the final stages of this project, we plan to work with classroom teachers in designing and pilot-testing experimental or prototypical curriculum projects which will address the identified targets of difficulty in learning and using tool software.

2.3. First year activities.

Research in the first year has addressed only the first two research questions, listed on page 11.

(1) In May, we conducted a survey of elementary and secondary teachers in the 18 districts served by Education Collaborative for

Greater Boston (EdCo). Respondents were asked about their present use of applications software, their planned use, the types of hardware and software available to them, and how they see applications software affecting the curriculum in their subject area. Approximately 200 instruments were distributed through the EdCo Computer Group Committee to teachers in their district. Approximately 75 completed instruments were returned. A review of the responses showed relatively limited applications software use, apart from word processing, even among teachers identified by EdCo representatives as being users. (See Appendix A.)

(2) During the summer we completed a review of the literature regarding applications software use.

(3) In June, July and August, we interviewed 7 teachers and 1 computer consultant who reported using these programs in their classrooms (and have been doing so for more than a few months) and who had developed curricula using applications software. A total of eight such interviews were conducted and have been transcribed.

(4) Also during the summer, we observed 11 teachers learning to use applications software during a week-long workshop. Observation records of difficulties were kept.

(5) From the observation records and interviews, we have developed a tentative list of difficulties for adult learners; this list is

being revised for children as we conduct our classroom observations. As a preliminary step in developing a more complete taxonomy of difficulties, we established a thesaurus of relevant terms and definitions. (See Appendix B). We have considered the possibility of establishing a data base of these difficulties; a sample printout from such a data base is provided in Appendix C.

3. Results.

3.1. Literature search.

The purpose of the literature search was to identify relevant research literature regarding applications software use with children. To this end, both manual and computer searches were conducted. A DIALOG search of the Eric database for articles published between 1966 and March 1984 was conducted in July 1984. The search included all articles which combined the descriptors databases, word processing, spreadsheets, computer graphics, Visicalc, Lotus, PFS, telecommunications, musical composition and simulations with elementary and/or secondary education and computer programs and/or microcomputers. A manual search covered the 1983 and 1984 Proceedings of the National Educational Computing Conference, the Distributed Union Catalog (DUC) of the Harvard University libraries, Psychological Abstracts, and the bibliographies of 1983 - 1984 courses at Harvard Graduate School of Education which concerned interactive technology. These searches yielded primarily anecdotal accounts by teachers of how

they used applications software in their classrooms and how they thought the computer should be used. The few research reports that we found had been given as papers at recent conferences or were technical reports. Some of the more useful references are listed in the bibliography.

3.2. Questionnaire survey.

A survey of elementary and secondary school teachers was conducted in May of 1984. Approximately 200 questionnaires were distributed through EdCo representatives to teachers in each of the 18 EdCo districts. Representatives were asked to select teachers from grades K - 12 who were most likely to be using applications software. The results of the survey are summarized below. (See Appendix A for details.)

3.2.1. Description of sample.

Seventy-one completed questionnaires were returned and analyzed. Ten districts were included in the final sample, with fairly even distribution across all three grade level groupings, elementary, middle school/junior high, and high school. The breakdown was as follows:

District	Elementary	Junior High	Senior High	Total
Acton	2	1	0	3
Archdiocese	0	1	5	6
Bedford	3	2	3	8
Cambridge	4	2	7	13
Concord	5	2	8	15
Lexington	5	1	2	8
Lincoln	2	2	0	4
Newton	0	1	0	1
Somerville	1	0	4	5
Sudbury	1	1	0	2
Watertown	4	2	0	6
Totals	27	15	29	71

At the elementary school level, the sample included 19 classroom teachers, 5 computer specialists, and 3 library media specialists. At the secondary level, the junior and senior high school respondents included 19 classroom teachers and 25 teachers of various computing courses who constituted almost 25% of the total sample.

3.2.2. Instructional orientation.

Approximately two-thirds of the respondents reported that they used computers for "teaching and learning" (drill-and-practice, tutorial use, and simulations). An equal percentage used the computer as a subject of instruction (introduction to computing, programming, and computer science); and a somewhat greater percentage (76%) indicated that they used computers as a "student tool" (word processing, data analysis, laboratory experiments). Elementary school teachers were somewhat more likely than those at other levels to be teaching computers as a "subject of instruction."

3.2.3. Computer use.

The most frequently-cited specific uses included word processing (cited as a use by more than 70% of the teachers), student problem-solving (58%), concept demonstration (54%), simulations (52%), instructional games (51%), and drill-and-practice (50%). Less frequently cited uses included scoring of tests, and as an instructional management aid. Although only 24% of teachers reported using computers for student data analysis, another 20% indicated that they planned to use computers in this way in the future.

3.2.4. Access to computers and other resources.

Approximately 44% of the respondents had a single microcomputer or computer terminal in their classrooms, 16% had two, and 15% had three or more. Only 18% said that they did not have a computer. Almost 75% of the teachers reported having access to computers in a computer lab. Teachers at the senior high level were somewhat more likely to have access to a computer lab than those at the elementary level. However, 44% of all respondents felt that their access to computers was "inadequate", with no significant differences across grade level.

As for specific types of hardware, well over half of the respondents reported having used standard peripherals such as a color monitor (66%), floppy disk drive (72%), printer (70%), and reference books or manuals (69%). Items such as light pens, music boards, optical

scanners, modems, and voice synthesizers were much less frequently available.

3.2.5. Interest and support.

More than 90% of the respondents indicated that student interest was "adequate", 78% reported an adequate level of administrative support, and 63% perceived adequate teacher and staff interest in computers. Areas seen as inadequate included the "quality of software" (63% viewed this as inadequate), and integration with the rest of the curriculum (61%). No significant differences were observed across grade level on these points.

3.2.6. Changes related to computer use.

Although most teachers (87%) indicated that there had been some sort of change in their classrooms related to the introduction of computers, there was less agreement about the actual nature of these changes. About 48% indicated that there had been a change in course content, and nearly 50% reported a change in teaching methods. However, almost 60% said that there had been no change in the amount of time available for individual attention. Here again, no significant differences across grade level were observed.

3.3. Teacher interviews.

Of the 71 teachers who returned the questionnaires, 59 indicated that they would be willing to be interviewed, and 45 said that they had classes available for observations. Of these, 14 appeared to

use commercially available tool software on a regular basis. Interviews were arranged and conducted with those 7 teachers who were available during the summer. An interview with a computer consultant working in an eighth-grade classroom was also arranged. The final sample of informants therefore comprised the following: four elementary classroom teachers, one elementary school computer specialist, one junior high computer teacher, one senior high computer teacher, and one computer consultant.

As a means of ensuring that the two research assistants conducting the interviews would elicit roughly comparable information, an interview protocol was developed and used. Interviews of approximately an hour to an hour and a half in length were conducted at the Educational Technology Center, or, in some cases, at the informant's home or school. All interviews were recorded and transcribed.

All of the interviewees taught in relatively affluent suburban school districts that were only beginning to use application software. For the elementary school teachers, 1983-84 was the first year that they had used applications programs in their classrooms. Each of the teachers had used only one applications program, although one teacher had taught a programming language (LOGO) for several years, and others had used other kinds of instructional and game software. Two of the three computer teachers had been involved in integrating applications programs into classrooms for several years. None of the teachers reported major problems with students

learning to use the software. Their remarks are summarized under pseudonyms on the following pages. These summaries are intended merely to give a general flavor of the interviews. A more detailed analysis of the transcripts will be completed in the next phase of our research.

3.3.1. Janet Porter.

Janet, a fourth grade teacher, had minimal experience using computers before introducing Bank Street Writer. She described the initial fears of many teachers: of being a failure at learning to use the computer, of knowing less than her students, and consequently, of "making a fool of herself" in front of them.

Once she overcame these fears, her major problems concerned logistics: availability of the hardware and software in the computer lab; compatibility of hardware, particularly between the Apple II+ and the IIe; and the problems with copy-protected disks, especially those which must remain in the disk drive, enabling only one person to use them at any one time.

She believed that the only problem her students had using Bank Street Writer related to keyboarding. She had required students to practice touch typing using MasterType before they started working with Bank Street Writer. She stated that the only student who had problems in her class was the one who refused to learn how to touch type.

3.3.2. Jean Porch.

Jean taught LOGO in 1983-84, and had become involved in several projects relating to the integration of computers into the classroom during the past two years. She, too, reported logistical problems relating to the availablility and placement of the computers in a computer lab, rather than the classroom, and the difficulty in using the Apple II+. Only a few of her students had trouble with the cursor movement when using Bank Street Writer and keyboarding was not a serious problem.

Her report emphasized how the positive experiences that her students had using Bank Street Writer contributed towards a positive attitude towards writing and revising. She also maintained that the program encouraged the students to cooperate with one another and to engage in independent troubleshooting.

3.3.3. Alice Lewis.

Alice, a fifth grade teacher, collaborated with her system's computer specialist, Martha Tierney (see below), on a project involving the integration of PFS File, Graph, and Report into a social studies unit on South America. Before the project Alice had taken several in-service workshops on LOGO and word processing programs, but because of the logistics involved in getting the software and the hardware at a time when she could practice, she had spent little time at a computer.

Alice gave many examples of problems that the students worked through in the broad area of information management; these included planning what information they needed and choosing consistent and appropriate terminology. She emphasized that these problems are encountered in classroom discussions, rather than at the computer. Another problem area that she identified involved selecting an appropriate and consistent unit of measurement. For example, the class had to decide whether to use square miles or some other unit as a measure of area. Measurement problems came up more frequently when they were using PFS Graph than when they were using PFS File.

Alice reported that some of her students just went though the motions of entering the data without understanding what they were doing or why. Because many of her students, especially the more knowledgeable ones, troubleshot for their classmates, she could not give examples of problems that her students had with special operations of the programs. Alice also reported some logistical problems, especially those related to time: having working equipment when it was needed, and having Martha, the computer specialist, available when she and the students needed her.

3.3.4. Martha Tierney.

Martha is an elementary computer specialist who has been involved with applications programs in the classroom for several years. Like Alice, she reported that the students' problems when using file

management programs related primarily to the organizational and planning skills involved in setting up and naming fields. She said that the most difficult tasks children had were not those experienced at the keyboard, but those that involved organizing themselves so that they arrived at the computer with the information that they needed before they went to enter it.

She also reported that time was a problem: because of the short time they were able to allot to the unit, she and Alice made it a precondition that the students use consistent terminology, rather than let the students find out that they would need it when they went to retrieve and compare data.

3.3.5. Caryn Johnson.

Caryn, a computer consultant who has had extensive experience with applications programs in the business field, piloted a "Thinking and Writing Skills" curriculum unit involving the data base program, Notebook, in a suburban 8th grade. She reported that the major difficulties that data bases, or file management programs raised for students were those involved in the planning that took place prior to entering data on the computer. She reported that not enough time was allotted for the unit; consequently she could not do as many activities as she thought necessary for the students to understand fully what they were doing.

3.3.6. Margaret Madison.

Margaret is the computer coordinator for her junior high school. She has been teaching computer programming, both LOGO and BASIC, since 1976. She has also taught students to use Applewriter. Margaret personally uses a word processor and is just learning to use file management and spreadsheet programs.

Since she had not yet attempted to teach these programs to her own students, most of the interview was concerned with difficulties encountered in teaching Applewriter. Generally speaking, Margaret conveyed the impression that these problems were not particularly serious. Although "keyboarding" was a problem initially for some children, others learned to type successfully using a typing tutor such as MasterType.

Some of the more persistent difficulties had to do with special control keys and compatibility problems. For example, Margaret reported that her students had difficulty remembering the many different commands in Applewriter. To get around this problem, she puts up special charts on the wall (one wall for LOGO commands and one wall for Applewriter commands). She also created a checklist of skills such as cursor movement, loading and saving files, etc., which students used to keep track of their own progress.

Another area of interest in the Madison interview related to attitudinal factors. Margaret saw children as more willing to experiment than adults; for this reason they were more capable of finding out

things about the programs on their own. She also noted that boys showed more interest in programming than girls, which she thought may have something to do with "sociability". In her experience, boys were more apt to be loners, and therefore more willing to spend long hours at the computer.

3.3.7. Arthur Nolan.

Arthur Nolan teaches a new tool software course at the senior high school level. In this course, which was first offered during the academic year 1983-1984, students learn to use file management programs, word processing, spreadsheets, and graphics packages. Arthur is an enthusiastic advocate of tool software use in the classroom. He thinks that students at this level can learn to use packages such as the PFS series without major difficulties. In doing so, they learn "problem-solving" skills.

In spite of the generally enthusiastic tone of the interview, the transcript contained a number of interesting examples of difficulties encountered in learning tool software. These included several of what Arthur refers to as "mindset" problems. Students had difficulty thinking creatively about how the tools could be applied to real-world problems. There was also an "enormous amount of frustration" when students got stuck with a problem they couldn't solve.

Another "mindset" problem involved attitudes toward finished products. Some students were satisfied when a product such as a document or data base structure "looked good". They didn't have sufficient perseverance or interest to work on clearing up underlying problems.

Other problems with data base structures were related to the need to plan ahead and foresee future demands on the system. Issues of formatting and retrieval were discussed. There was also an interesting discussion of the need for prior math knowledge in order to use spreadsheets effectively. For example, students need to have a good concept of what an "average" score is in order to set up the formula to get one.

3.3.8. Barry Wilson.

During the academic year 1984-1985, Barry taught in a self-contained fifth-grade classroom equipped with two microcomputers, one for LOGO and one for Quill. The interview transcript contains a large number of useful anecdotes concerning difficulties encountered by children learning to use these two programs.

Barry talked about children not "trusting" certain commands, perhaps out of fear of losing a file. Other difficulties that he mentioned involve file management, the difficulty of teaching structured programming, perseverance (something he thought girls had more of than boys), and "cultural issues" involving the relationship between

different teaching styles and successful use of computers in classrooms.

In another interesting section of the interview transcript, Barry discusses problems children encountered in the process of searching data bases, and in choosing appropriate keywords when setting up their own data bases using Quill.

3.4. Observations.

In mid-July, three researchers observed 11 teachers learning to use Applewriter II, PFS File, and Visicalc at the Cambridge Public Schools Applications Software Curriculum Project. Approximately half of the teachers had used other programs before, and a few of them had used them in their classes. The other teachers had had little experience at a computer.

The workshop was structured so that an experienced computer user was paired at the computer with a teacher with little or no experience providing those with less experience the opportunity to learn from their more experienced colleagues. We recorded a description of each observed problem, the time it took place, the program and teacher involved, and the solution.

Each of the three informal observation sessions lasted about an hour to an hour and a half. During the first two observation sessions, two of the observers each spent the entire session paired with one teacher who had little experience at the computer. In

addition to noting the difficulties experienced by their partners, they acted as a resource person for the teacher, offering suggestions or help when asked. The third observer during the first two sessions, and all three for the last session, each sat or stood behind a pair of teachers working at one computer. With the exception noted above, the observers rotated their attention every 20 to 30 minutes to a different pair. A short narrative description of the problem, its antecedents, and its resolution was then entered on a form. A total of 53 problems were recorded over a period of three days.

Most of the problems that we observed fell into two categories:

(1) performance of a particular program operation, such as how to move the cursor from one field to the next in a data base program or how to delete a line of text in a word processor.

(2) classification and organization of the data itself.

Examples of these latter problems include choosing and naming variables for the different fields in PFS (e.g. is 'two' the same as '2' in a PFS field asking for the 'number of years taught?') and understanding the meanings of entries in Visicalc (e.g., is the '2' in a Visicalc column, the same '2' as in the column label?)

At first glance the data suggest that the teachers with less experience at the computer solved many of these problems by asking their

partners or others for help, whereas the more experienced ones tried several solutions before seeking assistance. However, as mentioned before the workshop was structured specifically to elict this response; during the first session the strategy of asking others for help was identified as a good stratey.

Examples of these problems together with those identified in the interviews can be seen in Appendix C.

3.5. List of Targets of Difficulties.

From our interviews with teachers, our survey, the literature review, and our observations of teachers learning how to use applications software, we have developed a tentative list of the problem areas. These are listed alphabetically and defined in the thesaurus (Appendix B). Each term includes a scope statement or definition, and a list of the other terms in the thesaurus to which it is related. This list is broken down further into broader terms, narrower terms and related terms.

The terms represent a synthesis of the language of classroom teachers, computer specialists, and researchers in education and in cognitive psychology. The list includes the names of specific software packages, such as PFS, and names of generic types of applications software, such as "spreadsheets." Although many configurations are possible, we have tentatively grouped the data into the following six areas:

3.5.1. Keyboarding: Difficulties related to both where the keys are on the keyboard and how to use them; e.g. the shift and control keys are held down while another key is pressed, whereas all other keys are pressed sequentially.

3.5.2. Computer concepts: Difficulties related to understanding how the computer works, e.g. the importance of the cursor and its location; the different kinds of memory storage -- ROM, RAM, and disk or tape storage; understanding the importance of the data lines, etc.

3.5.3. Operations within specific programs: Problems in learning how to move the cursor from one line, word, field, or page to the next; how to save and access files; how to format a document; or how to get online help.

3.5.4. Information management: Difficulties inherent in understanding and using information. This is a large, amorphous area which needs further definition and delineation. Presently, it includes planning and organizing the data to allow for retrieval, and using appropriate and/or consistent terminology. Another set of problems is related to the lack of prior knowledge of the content area, such as math or geography, necessary to use the applications software appropriately. A third group of problems involves setting goals and evaluating data according to these goals.

3.5.5. Attitudes and beliefs: Attitudinal factors, such as those implied by the terms "perseverance" and "a willingness to experiment", which may affect how the individual works while at a computer. Eventually, these factors will need to be stated in terms of observable behavior.

3.5.6. Organizational constraints: Difficulties or constraints concerned with the composition of the classroom, the level and quality of the organizational support as well as the logistics of number, type, location and availability of hardware and software.

Appendix C provides a sample data base organized into the above categories. It includes examples of these difficulties as they have been experienced by both students and teachers.

4.0 Discussion

Our first year of research was based on the assumption that the demand for computer literacy and the enthusiasm with which teachers described their use of word processing, data base or file management and other applications software in their classroom would mean that we would have no difficulty in identifying users of applications software, and that these teacher users would have already identified a common set of "targets of difficulty" in their use. Our research, therefore, was designed to identify these difficulties through

interviewing and observing teachers who were proficient users of applications software.

In many regards, we were not correct in making the assumptions we did. Our survey suggested that the use of applications software was not as widespread as anticipated, even among computer-using teachers, and that the use of applications software was limited to a few types of programs. Moreover, while our interviews with the "heaviest" users (as identified from the survey) suggested that each teacher was aware of and able to identify or describe a group of student difficulties, these groups of difficulties (with some overlap) differed from one teacher to the next. Finally our observations have led us to conclude that the difficulties were broader than originally conceived. Our planned research for the future takes into account these preliminary findings.

5.0 Future plans.

Currently we are working on a number of different projects which serve to clarify and validate the opportunities and difficulties which we identified from the interviews and from our observations of teachers during the first year. Specifically we are:

(1) Expanding our observations into a variety of classrooms using a

range of techniques to collect data on student learners of applications software.

(2) Collecting data on difficulties encountered with implementing applications software use in the classroom.

(3) Analyzing the data from the first year's teacher interviews and observations in conjunction with the student observation data gathered as part of the second year's activities.

(4) Designing an experimental or prototype curriculum project to address some of the difficulties in learning to use applications software.

References

Academic Preparation for College. (1983). NY: The College Board.

Barbour, A. (1984, October). Computing in America's classrooms 1984: The new computer literacy emerges. Electronic Learning 4, 39 - 44.

Becker, H.J. (1982). National survey of school uses of microcomputers, Interim Reports 1-6. Baltimore, MD: Johns Hopkins.

Berman, P., McLaughlin, M.W. (1978). Federal programs supporting educational change: Vol VIII Implementing and sustaining innovations. Santa Monica, CA: Rand (Eric Document Reproduction Services No. ED 159 289).

Boyer, E.L. (1983). High school. NY: Harper.

Cohen, E., Intilli, J. (1981). Interdependence and management in bilingual classrooms. Unpublished manuscript. Stanford University.

Computers in Public Education Study. Highland Park, NJ: HBJ Enterprises. NIE. (ERIC No. ED 179 193).

Fetler, M. (1983). Computer literacy of California Sixth and twelfth grade students. Sacramento, CA: California Department of Education. Division of Planning Evaluation and Research.

Fullan, M. (1982). The meaning of educational change. NY: Teacher's College, Columbia University.

Gallup, G. (1983). The Gallup youth survey. Princeton, NJ: Gallop organization.

Hunter, B. (1983). My students use computers: Computer literacy in the K - 8 curriculum. Reston, VA: Reston.

Jamison, D., Suppes, P., Wells, S. (1974). The effectiveness of alternative instructional media: A survey. Review of Educational Research, 44, 1, 1-67.

Lockheed, M.E., Hunter, B., Anderson, R.E. (1983). Computer literacy: definition and survey items for assessment in schools. Washington, DC: National Center for Education Statistics.

Lockheed, M.E., Nielsen, A., Stone, M. (1983). Sex differences in microcomputer literacy. In D. Bonnette (Ed.). Proceedings

of NECC/5 National Educational Computing Conference 1983. IEEE Computer Society.

Miura, I., Hess, R.D. (1983). Sex differences in computer access, interest and usage. Paper presented at the annual meeting of the American Educational Research Association, Toronto.

National Science Board Commission on Precollege Education in Mathematics, Science and Technology. (1983). In Educating Americans for the 21st century. Washington, DC: National Science Foundation.

Wright, D. (1983). Instructional use of computers in public schools. Washington, DC: National Center for Education Statistics.

Bibliography

Abelson, Robert B. ed. (1983). Using microcomputers in the social studies classroom, Boulder, Colorado: Social Science Education Consortium.

Applications Software in elementary and secondary education. (1984, July). ERIC search (DIALOG).

Carroll, J., Mack, R. (1982). Learning to use a word processor: By doing, by thinking, and by knowing. Yorktown Heights. NY: IBM Watson Research Center.

Card, S., Moran, T. Newell, A. (1983). The psychology of human computer interaction. Hillsdale, NJ: Erlbaum.

Cazden, C., Michaels, S., Watson-Gegeo, K. (1984). Microcomputers and literacy project: First -- Fourth Quarterly Reports, (Grant # G-83-0051). Washington, DC: National Institute of Education.

Choate, Jon. (1984). Using Visicalc and Dynamo to make models and solve problems in high school math classes. in The computer as a teaching tool: promising practices. Educational Technology Center and Educational Collaborative for greater Boston. Conference Proceedings, July 12 and 13, 1984.

Hawkins, Jan, Kurland, D.M., Char, C., Freeman, C. (1984). Finding the ground: Tool software in education. NY: Center for Children and Technology; Bank Street College of Education.

Hunter, B. (1983). My students use computers: Learning activities for computer literacy. Reston, VA.: Reston Publishing Co.

November, Alan. (1984). Tool-based software as the focus of a computer literacy course: Problem solving, teamwork, and self-esteem. in The computer as a teaching tool: promising practices. Educational Technology Center and Educational Collaborative for greater Boston. Conference Proceedings, July 12 and 13, 1984.

Proceedings of the 6th Annual National Educational Computer Conference. (1984). Dayton, Ohio. NECC '84.

Stephens, Cindy. (1984). Using Quill, a computer-based writing program, with elementary school classes. in The computer as a teaching tool: promising practices. Educational Technology Center and Educational Collaborative for greater Boston. Conference Proceedings, July 12 and 13, 1984.

Wheeler, Fay. (1984). Using a database program in a Thinking and writing skills curriculum. in The computer as a teaching tool: promising practices. Educational Technology Center and Educational Collaborative for greater Boston. Conference Proceedings, July 12 and 13, 1984.

Appendix A

Crosstabulation of Questionnaire Responses by Grade Level

The following statistics were produced using a version of SPSS. Responses are compared across grade levels (elementary, junior high, and senior high): for example, the first table indicates that two of the respondents from the Acton school district were elementary school teacher and one a junior high teacher.

The "Chi square" statistic gives some indication as to whether the differences in the tables may be considered significant. A significance level of .05 (meaning a 95% probability that the observed difference is not just a matter of chance) is conventionally used as a cut-off point. For example, since the chi-square statistic in the first table has a significance level greater than .05, we may conclude that there are no significant differences; i.e., the respondents are, on the whole, more or less evenly distributed on these categories. Significance levels less than .05 are flagged with an asterisk.

Table 1 TEACHER'S SCHOOL DISTRICT

DISTRICT	LEVEL 1. ELEMENTARY	2. JUNIOR HIGH	3. SENIOR HIGH	ROW TOTAL
1. ACTON	2 / 66.7	1 / 33.3	0 / 0.0	3 / 4.2
2. ARCHDIOCESE	0 / 0.0	1 / 16.7	5 / 83.3	6 / 8.5
3. BEDFORD	3 / 37.5	2 / 25.0	3 / 37.5	8 / 11.3
4. CAMBRIDGE	4 / 30.8	2 / 15.4	7 / 53.8	13 / 18.3
5. CONCORD	5 / 33.3	2 / 13.3	8 / 53.3	15 / 21.1
6. LEXINGTON	5 / 62.5	1 / 12.5	2 / 25.0	8 / 11.3
7. LINCOLN	2 / 50.0	2 / 50.0	0 / 0.0	4 / 5.6
8. NEWTON	0 / 0.0	1 / 100.0	0 / 0.0	1 / 1.4
9. SOMERVILLE	1 / 20.0	0 / 0.0	4 / 80.0	5 / 7.0
10. SUDBURY	1 / 50.0	1 / 50.0	0 / 0.0	2 / 2.8
11. WATERTOWN	4 / 66.7	2 / 33.3	0 / 0.0	6 / 8.5
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 27.50469 WITH 20 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1217

Table 2 TEACHING ROLE

ROLE	COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. K-1		1	0	0	1
		100.0	0.0	0.0	1.4
2. SECOND GRADE		2	0	0	2
		100.0	0.0	0.0	2.8
3. THIRD GRADE		2	0	0	2
		100.0	0.0	0.0	2.8
4. FOURTH GRADE		4	0	0	4
		100.0	0.0	0.0	5.6
5. FIFTH GRADE		6	0	0	6
		100.0	0.0	0.0	8.5
6. SIXTH GRADE		4	0	0	4
		100.0	0.0	0.0	5.6
7. SEVENTH GRADE		0	1	0	1
		0.0	100.0	0.0	1.4

Table 2 TEACHING ROLE (Continued).

ROLE	COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
COMPUTER OR MEDIA SPECIALIST		5	0	0	5
		100.0	0.0	0.0	7.0
10. SCHOOL LIBRARIAN		3	0	0	3
		100.0	0.0	0.0	4.2
11. ENGLISH		0	1	3	4
		0.0	25.0	75.0	5.6
14. SOCIAL SCIENCE		0	0	1	1
		0.0	0.0	100.0	1.4
16. COMPUTER SCIENCE		0	5	3	8
		0.0	62.5	37.5	11.3
MATH AND OR SCIENCE		0	3	7	10
		0.0	30.0	70.0	14.1
ENGLISH, MATH AND ONE OTHER SUBJECT		0	2	0	2
		0.0	100.0	0.0	2.8
COMPUTERS AND OTHER SUBJECT		0	3	14	17
		0.0	17.6	82.4	23.9
OTHER		0	0	1	1
		0.0	0.0	100.0	1.4
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 90.32413 WITH 30 DEGREES OF FREEDOM
* SIGNIFICANCE = 0.0000

Table 3 COMPUTERS USED FOR TEACHING

	LEVEL			
COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
FOR TEACHING				
0. NO	6 / 25.0	5 / 20.8	13 / 54.2	24 / 33.8
1. YES	21 / 44.7	10 / 21.3	16 / 34.0	47 / 66.2
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 3.19491 WITH 2 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2024

- -

Table 4 COMPUTERS AS SUBJECT

	LEVEL			
COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
AS SUBJECT				
0. NO	5 / 21.7	4 / 17.4	14 / 60.9	23 / 32.4
1. YES	22 / 45.8	11 / 22.9	15 / 31.2	48 / 67.6
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 5.93829 WITH 2 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0513

Table 5 COMPUTERS AS TOOL

AS TOOL	LEVEL	1.ELEMENTARY	2.JUNIOR HIGH	3.SENIOR HIGH	ROW TOTAL
0. NO	COUNT	5	4	7	16
	ROW PCT	31.2	25.0	43.7	22.5
1. YES	COUNT	22	11	21	54
	ROW PCT	40.7	20.4	38.9	76.1
9. OTHER	COUNT	0	0	1	1
	ROW PCT	0.0	0.0	100.0	1.4
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 1.95795 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7435

Table 6 NUMBER OF COMPUTERS IN CLASSROOM

COMPUTERS		1.ELEMENTARY	2.JUNIOR HIGH	3.SENIOR HIGH	ROW TOTAL
0. NONE	COUNT	3	3	7	13
	ROW PCT	23.1	23.1	53.8	18.3
1. ONE	COUNT	13	7	11	31
	ROW PCT	41.9	22.6	35.5	43.7
2. TWO	COUNT	6	1	4	11
	ROW PCT	54.5	9.1	36.4	15.5
3. THREE	COUNT	0	1	3	4
	ROW PCT	0.0	25.0	75.0	5.6
4. FOUR	COUNT	1	1	0	2
	ROW PCT	50.0	50.0	0.0	2.8
5. FIVE	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	1.4
6. SIX	COUNT	1	1	1	3
	ROW PCT	33.3	33.3	33.3	4.2

Table 7 NUMBER OF COMPUTERS IN CLASSROOM (Continued)

	LEVEL			
COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
7. SEVEN	1 100.0	0 0.0	0 0.0	1 1.4
8. EIGHT	1 50.0	1 50.0	0 0.0	2 2.8
9. NO RESPONSE	0 0.0	0 0.0	3 100.0	3 4.2
COLUMN TOTAL	27 38.0	15 21.1	29 40.8	71 100.0

CHI SQUARE = 17.22608 WITH 18 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5076

- -

Table 8 ACCESS TO OUTSIDE COMPUTERS?

	LEVEL			
COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
ACCESS	1.	2.	3.	
0. NO	8 57.1	5 35.7	1 7.1	14 19.7
1. YES	18 34.0	10 18.9	25 47.2	53 74.6
2.	1 100.0	0 0.0	0 0.0	1 1.4
9. OTHER	0 0.0	0 0.0	3 100.0	3 4.2
COLUMN TOTAL	27 38.0	15 21.1	29 40.8	71 100.0

CHI SQUARE = 13.50035 WITH 6 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0357

- -

Table 9 COURSE CONTENT CHANGED?

		LEVEL			
	COUNT	I			
	ROW PCT	IELEMENTA	JUNIOR H	SENIOR H	ROW
		IRY	IGH	IGH	TOTAL
		I 1.I	2.I	3.I	
CONTENT					
	0.	12	6	16	34
NO		35.3	17.6	47.1	47.9
	1.	15	9	10	34
YES		44.1	26.5	29.4	47.9
	9.	0	0	3	3
OTHER		0.0	0.0	100.0	4.2
	COLUMN	27	15	29	71
	TOTAL	38.0	21.1	40.8	100.0

CHI SQUARE = 6.80717 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1464

Table 10 STUDENT GROUPING CHANGED?

		LEVEL			
	COUNT	I			
	ROW PCT	IELEMENTA	JUNIOR H	SENIOR H	ROW
		IRY	IGH	IGH	TOTAL
		I 1.I	2.I	3.I	
GROUPING					
	0.	15	8	18	41
NO		36.6	19.5	43.9	57.7
	1.	12	7	8	27
YES		44.4	25.9	29.6	38.0
	9.	0	0	3	3
OTHER		0.0	0.0	100.0	4.2
	COLUMN	27	15	29	71
	TOTAL	38.0	21.1	40.8	100.0

CHI SQUARE = 5.92983 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2045

Table 11 PACING OF INSTRUCTION CHANGED?

PACING	LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
0. NO	18	8	15	41
	43.9	19.5	36.6	57.7
1. YES	9	7	11	27
	33.3	25.9	40.7	38.0
9. OTHER	0	0	3	3
	0.0	0.0	100.0	4.2
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 5.40051 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2486

- -

Table 12 PEDAGOGY CHANGED?

PEDAGOGY	LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
0. NO	13	10	10	33
	39.4	30.3	30.3	46.5
1. YES	14	5	16	35
	40.0	14.3	45.7	49.3
9. OTHER	0	0	3	3
	0.0	0.0	100.0	4.2
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 7.58844 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1079

- -

Table 13 ANY MORE/LESS TIME FOR INDIVIDUAL ATTENTION?

TIME	LEVEL	ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
0. NO	COUNT	17	9	17	43
	ROW PCT	39.5	20.9	39.5	60.6
1. YES	COUNT	10	6	9	25
	ROW PCT	40.0	24.0	36.0	35.2
9. OTHER	COUNT	0	0	3	3
	ROW PCT	0.0	0.0	100.0	4.2
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 4.65629 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3244

- -

Table 14 DO NOT USE COMPUTERS IN CLASS

NOUSE	LEVEL	ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
0. NO	COUNT	26	15	26	67
	ROW PCT	38.8	22.4	38.8	94.4
1. YES	COUNT	1	0	0	1
	ROW PCT	100.0	0.0	0.0	1.4
9. OTHER	COUNT	0	0	3	3
	ROW PCT	0.0	0.0	100.0	4.2
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 6.10377 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1915

- -

Table 15 THERE HAVE BEEN NO CHANGES

	LEVEL			
COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
NOCHANGE				
0. NO	26 / 41.9	13 / 21.0	23 / 37.1	62 / 87.3
1. YES	1 / 16.7	2 / 33.3	3 / 50.0	6 / 8.5
9. OTHER	0 / 0.0	0 / 0.0	3 / 100.0	3 / 4.2
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 6.07399 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1937

- -

Table 16 USE COMPUTER FOR NUMERIC CALCULATIONS

ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
CALCULAT				
1. CURRENT USE	6 / 23.1	6 / 23.1	14 / 53.8	26 / 36.6
2. FUTURE PLANS	3 / 42.9	2 / 28.6	2 / 28.6	7 / 9.9
3. DON'T KNOW	1 / 20.0	2 / 40.0	2 / 40.0	5 / 7.0
4. CURRENT/FUTURE	2 / 33.3	2 / 33.3	2 / 33.3	6 / 8.5
5. NO RESPONSE	15 / 55.6	3 / 11.1	9 / 33.3	27 / 38.0
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 8.78406 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3608

Table 17 USE COMPUTERS TO RUN SIMULATIONS

SIMULATE	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
CURRENT USE	1.	13	4	11	28
		46.4	14.3	39.3	39.4
FUTURE PLANS	2.	2	5	5	12
		16.7	41.7	41.7	16.9
DON'T KNOW	3.	1	0	2	3
		33.3	0.0	66.7	4.2
CURRENT/FUTURE	4.	4	3	2	9
		44.4	33.3	22.2	12.7
NO RESPONSE	5.	7	3	9	19
		36.8	15.8	47.4	26.8
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 8.09317 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.4244

Table 18 USE COMPUTER FOR INSTRUCTIONAL GAMES

GAMES	ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
CURRENT USE	1.	15	5	7	27
		55.6	18.5	25.9	38.0
FUTURE PLANS	2.	2	3	5	10
		20.0	30.0	50.0	14.1
DON'T KNOW	3.	1	1	4	6
		16.7	16.7	66.7	8.5
CURRENT/FUTURE	4.	3	3	3	9
		33.3	33.3	33.3	12.7
NO RESPONSE	5.	6	3	10	19
		31.6	15.8	52.6	26.8
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 8.84936 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3552

Table 19 COMPUTER USED FOR LIESURE AND REWARD

REWARD	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
CURRENT USE	1.	11	5	6	22
		50.0	22.7	27.3	31.0
FUTURE PLANS	2.	0	2	0	2
		0.0	100.0	0.0	2.8
DON'T KNOW	3.	1	3	7	11
		9.1	27.3	63.6	15.5
CURRENT/FUTURE	4.	3	2	1	6
		50.0	33.3	16.7	8.5
NO RESPONSE	5.	12	3	15	30
		40.0	10.0	50.0	42.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 17.24477 WITH 8 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0277

Table 20 COMPUTER USED FOR STUDENT PROBLEM-SOLVING

PROBLEMS	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
CURRENT USE	1.	14	6	11	31
		45.2	19.4	35.5	43.7
FUTURE PLANS	2.	4	3	5	12
		33.3	25.0	41.7	16.9
DON'T KNOW	3.	0	0	3	3
		0.0	0.0	100.0	4.2
CURRENT/FUTURE	4.	5	3	2	10
		50.0	30.0	20.0	14.1
NO RESPONSE	5.	4	3	8	15
		26.7	20.0	53.3	21.1
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 8.08487 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.4252

Table 21 COMPUTER USED FOR DRILL-AND-PRACTICE

DRILL	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
1. CURRENT USE		11	8	9	28
		39.3	28.6	32.1	39.4
2. FUTURE PLANS		3	1	8	12
		25.0	8.3	66.7	16.9
3. DON'T KNOW		0	2	0	2
		0.0	100.0	0.0	2.8
4. CURRENT/FUTURE		3	3	2	8
		37.5	37.5	25.0	11.3
5. NO RESPONSE		10	1	10	21
		47.6	4.8	47.6	29.6
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 17.06949 WITH 8 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0294

Table 22 COMPUTER USED AS TUTOR

TUTOR	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
1. CURRENT USE		10	6	11	27
		37.0	22.2	40.7	38.0
2. FUTURE PLANS		5	3	4	12
		41.7	25.0	33.3	16.9
3. DON'T KNOW		0	1	0	1
		0.0	100.0	0.0	1.4
4. CURRENT/FUTURE		2	2	1	5
		40.0	40.0	20.0	7.0
5. NO RESPONSE		10	3	13	26
		38.5	11.5	50.0	36.6
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 7.09472 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5264

Table 23 COMPUTER USED TO DEMONSTRATE CONCEPTS

DEMO	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
		1.	2.	3.	
CURRENT USE	1.	12	7	13	32
		37.5	21.9	40.6	45.1
FUTURE PLANS	2.	6	0	6	12
		50.0	0.0	50.0	16.9
DON'T KNOW	3.	0	1	1	2
		0.0	50.0	50.0	2.8
CURRENT/FUTURE	4.	2	3	2	7
		28.6	42.9	28.6	9.9
NO RESPONSE	5.	7	4	7	18
		38.9	22.2	38.9	25.4
	COLUMN TOTAL	27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 6.85370 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5525

Table 24 COMPUTER USED TO SCORE TESTS

SCORING	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
		1.	2.	3.	
CURRENT USE	1.	1	1	5	7
		14.3	14.3	71.4	9.9
FUTURE PLANS	2.	4	6	2	12
		33.3	50.0	16.7	16.9
DON'T KNOW	3.	2	3	6	11
		18.2	27.3	54.5	15.5
CURRENT/FUTURE	4.	0	1	0	1
		0.0	100.0	0.0	1.4
NO RESPONSE	5.	20	4	16	40
		50.0	10.0	40.0	56.3
	COLUMN TOTAL	27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 18.75138 WITH 8 DEGREES OF FREEDOM * *
*SIGNIFICANCE = 0.0162

Table 25 COMPUTER USED AS MANAGEMENT AID

ROW PCT	ELEMENTARY 1.0	JUNIOR HIGH 2.0	SENIOR HIGH 3.0	ROW TOTAL
CMI 1. CURRENT USE	5 / 31.2	3 / 18.7	8 / 50.0	16 / 22.5
2. FUTURE PLANS	5 / 31.2	5 / 31.2	6 / 37.5	16 / 22.5
3. DON'T KNOW	2 / 66.7	0 / 0.0	1 / 33.3	3 / 4.2
4. CURRENT/FUTURE	2 / 40.0	2 / 40.0	1 / 20.0	5 / 7.0
5. NO RESPONSE	13 / 41.9	5 / 16.1	13 / 41.9	31 / 43.7
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 4.77992 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7808

Table 26 COMPUTER USED AS MATERIALS GENERATOR

ROW PCT	ELEMENTARY 1.0	JUNIOR HIGH 2.0	SENIOR HIGH 3.0	ROW TOTAL
MATERIAL 1. CURRENT USE	8 / 34.8	5 / 21.7	10 / 43.5	23 / 32.4
2. FUTURE PLANS	7 / 41.2	4 / 23.5	6 / 35.3	17 / 23.9
3. DON'T KNOW	0 / 0.0	1 / 50.0	1 / 50.0	2 / 2.8
4. CURRENT/FUTURE	1 / 14.3	2 / 28.6	4 / 57.1	7 / 9.9
5. NO RESPONSE	11 / 50.0	3 / 13.6	8 / 36.4	22 / 31.0
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 5.11471 WITH 8 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7452

Table 27 ACCESS TO COMPUTERS

ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
ACCESS				
0. INADEQUATE	11	7	13	31
	35.5	22.6	41.9	43.7
1. ADEQUATE	11	6	12	29
	37.9	20.7	41.4	40.8
5. NO RESPONSE	5	2	4	11
	45.5	18.2	36.4	15.5
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 0.35630 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.9859

- -

Table 28 STUDENT INTEREST

ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
INTEREST				
0. INADEQUATE	0	0	1	1
	0.0	0.0	100.0	1.4
1. ADEQUATE	25	15	25	65
	38.5	23.1	38.5	91.5
5. NO RESPONSE	2	0	3	5
	40.0	0.0	60.0	7.0
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 3.16951 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5299

- -

Table 29 QUALITY OF SOFTWARE

ROW PCT	ELEMENTARY 1.0	JUNIOR HIGH 2.0	SENIOR HIGH 3.0	ROW TOTAL
QUALITY				
0. INADEQUATE	16 / 35.6	11 / 24.4	18 / 40.0	45 / 63.4
1. ADEQUATE	7 / 43.7	3 / 18.7	6 / 37.5	16 / 22.5
5. NO RESPONSE	4 / 40.0	1 / 10.0	5 / 50.0	10 / 14.1
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 1.34046 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.8545

- -

Table 30 ALLOCATION OF FUNDS

ROW PCT	ELEMENTARY 1.0	JUNIOR HIGH 2.0	SENIOR HIGH 3.0	ROW TOTAL
FUNDS				
0. INADEQUATE	10 / 45.5	5 / 22.7	7 / 31.8	22 / 31.0
1. ADEQUATE	10 / 37.0	5 / 18.5	12 / 44.4	27 / 38.0
5. NO RESPONSE	7 / 31.8	5 / 22.7	10 / 45.5	22 / 31.0
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 1.32840 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.8565

- -

Table 31 INTEGRATION WITH CURRICULUM

ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
INTEGRAT				
0. INADEQUATE	14 / 32.6	11 / 25.6	18 / 41.9	43 / 60.6
1. ADEQUATE	10 / 52.6	3 / 15.8	6 / 31.6	19 / 26.8
5. NO RESPONSE	3 / 33.3	1 / 11.1	5 / 55.6	9 / 12.7
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 3.43049 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.4885

- -

Table 32 MANAGING STUDENT USE

COUNT / ROW PCT	LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
MANAGE				
0. INADEQUATE	4 / 21.1	7 / 36.8	8 / 42.1	19 / 26.8
1. ADEQUATE	19 / 43.2	7 / 15.9	18 / 40.9	44 / 62.0
5. NO RESPONSE	4 / 50.0	1 / 12.5	3 / 37.5	8 / 11.3
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 5.14784 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2725

Table 33 TEACHER OR STAFF TRAINING

TRAINING	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
0. INADEQUATE	COUNT	6	5	13	24
	ROW PCT	25.0	20.8	54.2	33.8
1. ADEQUATE	COUNT	18	7	13	38
	ROW PCT	47.4	18.4	34.2	53.5
5. NO RESPONSE	COUNT	3	3	3	9
	ROW PCT	33.3	33.3	33.3	12.7
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 4.33913 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3621

Table 34 TEACHER OR STAFF INTEREST

ENTHUS	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
0. INADEQUATE	COUNT	3	4	6	13
	ROW PCT	23.1	30.8	46.2	18.3
1. ADEQUATE	COUNT	19	7	19	45
	ROW PCT	42.2	15.6	42.2	63.4
5. NO RESPONSE	COUNT	5	4	4	13
	ROW PCT	38.5	30.8	30.8	18.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 3.21204 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5230

Table 35 ADMINISTRATIVE SUPPORT

ADMIN	LEVEL	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
0. INADEQUATE	COUNT	1	3	2	6
	ROW PCT	16.7	50.0	33.3	8.5
1. ADEQUATE	COUNT	22	10	24	56
	ROW PCT	39.3	17.9	42.9	78.9
5. NO RESPONSE	COUNT	4	2	3	9
	ROW PCT	44.4	22.2	33.3	12.7
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 3.75949 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.4395

- -

Table 36 COLOR MONITOR

MONITOR	LEVEL	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE	COUNT	6	3	3	12
	ROW PCT	50.0	25.0	25.0	16.9
2. NOT AVAILABLE	COUNT	0	0	4	4
	ROW PCT	0.0	0.0	100.0	5.6
3. HAVE USED	COUNT	18	11	18	47
	ROW PCT	38.3	23.4	38.3	66.2
5. NO RESPONSE	COUNT	3	1	4	8
	ROW PCT	37.5	12.5	50.0	11.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 7.70570 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2605

Table 37 CATHODE RAY TUBE (CRT)

CRT	ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
1. AVAILABLE		4	3	6	13
		30.8	23.1	46.2	18.3
2. NOT AVAILABLE		2	0	0	2
		100.0	0.0	0.0	2.8
3. HAVE USED		12	11	17	40
		30.0	27.5	42.5	56.3
5. NO RESPONSE		9	1	6	16
		56.2	6.2	37.5	22.5
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 8.14324 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2278

Table 38 FLOPPY DISK DRIVE

FLOPPY	LEVEL / COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE		4	3	5	12
		33.3	25.0	41.7	16.9
2. NOT AVAILABLE		0	0	1	1
		0.0	0.0	100.0	1.4
3. HAVE USED		20	11	20	51
		39.2	21.6	39.2	71.8
5. NO RESPONSE		3	1	3	7
		42.9	14.3	42.9	9.9
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 1.86672 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.9315

Table 39 GRAPHICS PLOTTER

PLOTTER	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
1. AVAILABLE		1	1	4	6
		16.7	16.7	66.7	8.5
2. NOT AVAILABLE		11	11	15	37
		29.7	29.7	40.5	52.1
3. HAVE USED		3	0	2	5
		60.0	0.0	40.0	7.0
5. NO RESPONSE		12	3	8	23
		52.2	13.0	34.8	32.4
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 7.54343 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.2735

Table 40 GRAPHICS TABLET BY LEVEL

TABLET	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
1. AVAILABLE		2	3	2	7
		28.6	42.9	28.6	9.9
2. NOT AVAILABLE		8	7	18	33
		24.2	21.2	54.5	46.5
3. HAVE USED		5	3	1	9
		55.6	33.3	11.1	12.7
5. NO RESPONSE		12	2	8	22
		54.5	9.1	36.4	31.0
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 11.65804 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.0700

Table 41 HARD DISK DRIVE BY LEVEL

HARD	COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE		1	0	4	5
		20.0	0.0	80.0	7.0
2. NOT AVAILABLE		10	8	15	33
		30.3	24.2	45.5	46.5
3. HAVE USED		1	2	4	7
		14.3	28.6	57.1	9.9
5. NO RESPONSE		15	5	6	26
		57.7	19.2	23.1	36.6
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 10.57567 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1024

- -

Table 42 JOYSTICK OR GAME PADDLE

JOYSTICK	COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE		3	4	4	11
		27.3	36.4	36.4	15.5
2. NOT AVAILABLE		6	4	10	20
		30.0	20.0	50.0	28.2
3. HAVE USED		8	5	6	19
		42.1	26.3	31.6	26.8
5. NO RESPONSE		10	2	9	21
		47.6	9.5	42.9	29.6
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 4.95046 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5502

Table 43 LIGHT PEN

COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
LIGHTPEN				
2. NOT AVAILABLE	12 / 30.0	9 / 22.5	19 / 47.5	40 / 56.3
3. HAVE USED	1 / 50.0	1 / 50.0	0 / 0.0	2 / 2.8
5. NO RESPONSE	14 / 48.3	5 / 17.2	10 / 34.5	29 / 40.8
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 4.12430 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3894

- -

Table 44 MAGAZINES

LEVEL

COUNT / ROW PCT	ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
MAGS				
1. AVAILABLE	6 / 42.9	2 / 14.3	6 / 42.9	14 / 19.7
2. NOT AVAILABLE	3 / 50.0	1 / 16.7	2 / 33.3	6 / 8.5
3. HAVE USED	12 / 34.3	9 / 25.7	14 / 40.0	35 / 49.3
5. NO RESPONSE	6 / 37.5	3 / 18.7	7 / 43.7	16 / 22.5
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 1.33606 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.9696

- -

Table 45 TAPE DRIVE OR CASSETTE

TAPE	ROW PCT	ELEMENTA	JUNIOR H	SENIOR H	ROW
1. AVAILABLE		1	0	2	3
		33.3	0.0	66.7	4.2
2. NOT AVAILABLE		9	5	11	25
		36.0	20.0	44.0	35.2
3. HAVE USED		2	6	5	13
		15.4	46.2	38.5	18.3
5. NO RESPONSE		15	4	11	30
		50.0	13.3	36.7	42.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 8.99031 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1741

- -

Table 46 MAINFRAME COMPUTER

	LEVEL			
COUNT				
MAINFRAM ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
1. AVAILABLE	2	1	4	7
	28.6	14.3	57.1	9.9
2. NOT AVAILABLE	8	5	7	20
	40.0	25.0	35.0	28.2
3. HAVE USED	6	4	12	22
	27.3	18.2	54.5	31.0
5. NO RESPONSE	11	5	6	22
	50.0	22.7	27.3	31.0
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 4.72321 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5798

Table 47 "MOUSE" BY LEVEL

COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
	1.	2.	3.	
MOUSE				
1. AVAILABLE	0	1	0	1
	0.0	100.0	0.0	1.4
2. NOT AVAILABLE	13	8	20	41
	31.7	19.5	48.8	57.7
3. HAVE USED	2	3	1	6
	33.3	50.0	16.7	8.5
5. NO RESPONSE	12	3	8	23
	52.2	13.0	34.8	32.4
COLUMN TOTAL	27	15	29	71
	38.0	21.1	40.8	100.0

CHI SQUARE = 10.23644 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1150

- - - -

Table 49 OPTICAL SCANNER

SCANNER	LEVEL 1. ELEMENTARY	2. JUNIOR HIGH	3. SENIOR HIGH	ROW TOTAL
1. AVAILABLE	0 / 0.0	1 / 50.0	1 / 50.0	2 / 2.8
2. NOT AVAILABLE	13 / 33.3	10 / 25.6	16 / 41.0	39 / 54.9
3. HAVE USED	0 / 0.0	1 / 33.3	2 / 66.7	3 / 4.2
5. NO RESPONSE	14 / 51.9	3 / 11.1	10 / 37.0	27 / 38.0
COLUMN TOTAL	27 / 38.0	15 / 21.1	29 / 40.8	71 / 100.0

CHI SQUARE = 6.77013 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.3426

- - - -

Table 51 PERSONS TO ASSIST

PEOPLE	COUNT / ROW PCT	LEVEL: ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE		7	2	7	16
		43.7	12.5	43.7	22.5
2. NOT AVAILABLE		2	1	0	3
		66.7	33.3	0.0	4.2
3. HAVE USED		14	10	15	39
		35.9	25.6	38.5	54.9
5. NO RESPONSE		4	2	7	13
		30.8	15.4	53.8	18.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 4.21636 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.6474

- -

Table 52 PRINTER

PRINTER	COUNT / ROW PCT	LEVEL: ELEMENTARY 1.	JUNIOR HIGH 2.	SENIOR HIGH 3.	ROW TOTAL
1. AVAILABLE		5	3	6	14
		35.7	21.4	42.9	19.7
3. HAVE USED		19	11	20	50
		38.0	22.0	40.0	70.4
5. NO RESPONSE		3	1	3	7
		42.9	14.3	42.9	9.9
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 0.26592 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.9919

- -

Table 53 REFERENCE BOOKS AND MANUALS

BOOKS	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
1. AVAILABLE		4	4	6	14
		28.6	28.6	42.9	19.7
3. HAVE USED		19	11	19	49
		38.8	22.4	38.8	69.0
5. NO RESPONSE		4	0	4	8
		50.0	0.0	50.0	11.3
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 2.96532 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.5636

- -

Table 54 MODEM

MODEM	COUNT / ROW PCT	LEVEL: ELEMENTARY (1.)	JUNIOR HIGH (2.)	SENIOR HIGH (3.)	ROW TOTAL
1. AVAILABLE		0	0	1	1
		0.0	0.0	100.0	1.4
2. NOT AVAILABLE		12	9	15	36
		33.3	25.0	41.7	50.7
3. HAVE USED		3	2	2	7
		42.9	28.6	28.6	9.9
5. NO RESPONSE		12	4	11	27
		44.4	14.8	40.7	38.0
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 3.20478 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7827

- -

Table 55 TELEPHONE MODEM

MODEM	LEVEL / COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
1. AVAILABLE		0	0	1	1
		0.0	0.0	100.0	1.4
2. NOT AVAILABLE		12	9	15	36
		33.3	25.0	41.7	50.7
3. HAVE USED		3	2	2	7
		42.9	28.6	28.6	9.9
5. NO RESPONSE		12	4	11	27
		44.4	14.8	40.7	38.0
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 3.20478 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7827

- -

Table 56 TEXTBOOKS

TEXTS	LEVEL / COUNT / ROW PCT	ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
1. AVAILABLE		3	2	10	15
		20.0	13.3	66.7	21.1
2. NOT AVAILABLE		7	5	0	12
		58.3	41.7	0.0	16.9
3. HAVE USED		7	5	13	25
		28.0	20.0	52.0	35.2
5. NO RESPONSE		10	3	6	19
		52.6	15.8	31.6	26.8
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 15.91946 WITH 6 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0142

Table 57 VOICE SYNTHESIZER

VOICE		LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
AVAILABLE	1.	1	2	0	3
	ROW PCT	33.3	66.7	0.0	4.2
NOT AVAILABLE	2.	11	7	16	34
	ROW PCT	32.4	20.6	47.1	47.9
HAVE USED	3.	2	1	2	5
	ROW PCT	40.0	20.0	40.0	7.0
NO RESPONSE	5.	13	5	11	29
	ROW PCT	44.8	17.2	37.9	40.8
	COLUMN TOTAL	27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 5.43075 WITH 6 DEGREES OF FREEDOM
SIGNIFICANCE = 0.4899

- -

Table 58 EST. LEVEL OF TOOL USE

TOOLS		LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
LOW	1.	3	4	14	21
	ROW PCT	14.3	19.0	66.7	29.6
MEDIUM	2.	8	8	12	28
	ROW PCT	28.6	28.6	42.9	39.4
HIGH	3.	8	3	3	14
	ROW PCT	57.1	21.4	21.4	19.7
	9.	8	0	0	8
	ROW PCT	100.0	0.0	0.0	11.3
	COLUMN TOTAL	27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 23.67962 WITH 6 DEGREES OF FREEDOM
*SIGNIFICANCE = 0.0006

- -

Table 59 AVAILABLE FOR INTERVIEW?

READY	COUNT / ROW PCT	LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
0. NO		3	2	5	10
		30.0	20.0	50.0	14.1
1. YES		23	12	24	59
		39.0	20.3	40.7	83.1
9. DEPENDS		1	1	0	2
		50.0	50.0	0.0	2.8
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 2.09405 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.7185

- -

Table 60 HAVE CLASS TO OBSERVE?

OBSERVE	COUNT / ROW PCT	LEVEL: ELEMENTARY	JUNIOR HIGH	SENIOR HIGH	ROW TOTAL
0. NO		5	5	13	23
		21.7	21.7	56.5	32.4
1. YES		21	10	14	45
		46.7	22.2	31.1	63.4
9. DEPENDS		1	0	2	3
		33.3	0.0	66.7	4.2
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 6.08613 WITH 4 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1928

- -

Table 61 HAVE BEEN INTERVIEWED?

INTERVIEW?	LEVEL	1. ELEMENTARY	2. JUNIOR HIGH	3. SENIOR HIGH	ROW TOTAL
0. NO	COUNT	22	14	28	64
	ROW PCT	34.4	21.9	43.7	90.1
1. YES	COUNT	5	1	1	7
	ROW PCT	71.4	14.3	14.3	9.9
COLUMN TOTAL		27	15	29	71
		38.0	21.1	40.8	100.0

CHI SQUARE = 3.79127 WITH 2 DEGREES OF FREEDOM
SIGNIFICANCE = 0.1502

Appendix B

Thesaurus of Keywords Describing Targets of Difficulty

for Applications Software

Draft 4

Introduction

This is an alphabetical list of keywords describing the difficulites people experience when learning and using applications software. We have taken these terms from our interviews with teachers, the records of our observation of teachers learning new applications software and from the literature. These terms will be used in the data base we plan to set up in the spring. This data base will aid our analysis and allow us to quickly obtain examples of specific difficulties that students and teachers have when learning and using applications packages.

Besides terms describing difficulties, the list includes names of specific software packages, such as PFS, and names of generic types of applications software, such as "spreadsheets" because they will be entered into our data base. We will then be able to ask for all the difficulties that people have using a particular kind of tool or a specific software package.

The list is a constantly changing one; please make any suggestions that will make the list more accurate, precise, consistent and/or elegant. Many terms represent compromises that none of us like, but we haven't been able to think of a better one. A major problem is reconciling the differences in the terminology of teachers and that of researchers and that of both with terminology of those working with computers, a field in which the vocabulary is still evolving.

bt: broader term rt: related term nt: narrower term

Applewriter
 bt: word processing

Appleworks
 bt: integrated packages

applications
 scope: use of software in a curriculum or in a real-world problem, or transfer of idea from one piece of software or hardware to another and the selection of the proper tool
 bt: mindset
 rt: compatibility

Bank Street Writer
 bt: word processing

classification
 scope: putting information, etc. into separate classes or groups

 bt: information management
 data bases
 rt: search strategies
 organization
 evaluation

compatibility
 scope: ability and ease of integrating one program with another
 bt: computer concepts
 information management
 rt: file management
 applications

computer concepts
 scope: understanding how a computer or a particular piece of software works
 rt: keyboarding
 nt: computer literacy
 cursor
 data type
 editing
 file management
 compatibility
 memory
 modes
 sequence
 screen focus
 special keys
 transfer

bt: broader term rt: related term nt: narrower term

computer literacy
 scope: awareness of potentials and limitations of specific hardware and software and of computers in general
 bt: computer concepts
 nt: compatibility

cursor
 scope: understanding the importance of the cursor and what it indicates to the ability to move it within specific software
 bt: computer concepts
 rt: editing
 word processing
 data bases
 spreadsheets
 special keys

data bases
 bt: information management

data type
 scope: distinction between integers and strings

domain specific knowledge
 scope: knowledge of specific subject such as knowing what percents or averages or what it means if a city is the country's capitol

editing
 scope: changing text or data within a specific text or file, such as deleting, moving text from one place to another [needs work: either a broader term needs to be delineated with includes proofreading, formatting, and contextual changes, or a narrower term needs to 'named']
 bt: computer concepts
 word processing
 rt: cursor
 evaluation
 format
 special keys
 modes
 screen focus

enthusiasm [is this a difficulty, or only a success?]
 rt: mindset
 perseverance

bt: broader term rt: related term nt: narrower term

evaluation
 scope: looking at information, data, or text critically and making judgments concerning the accuracy, appropriateness, clarity, and format of the information, text, [does this need delineation?]
 rt: editing
 nt: formatting

experimentation
 scope: learning by trial and error, or through mistakes
 bt: mindset
 rt: literacy
 perseverance

file management
 scope: organizing, naming, saving and storing of files to disk [needs work?]
 bt: computer concepts
 information management
 rt: literacy
 nt: organization
 unit of analysis

format
 scope: how information will be placed on the screen or on the page
 rt: editing
 organization

graphs and graphing
 bt: integrated packages

help
 scope: knowing how and where to get help (includes sharing of information among individuals)
 bt: computer concepts
 mindware
 rt: mindset
 experimentation
 logistics
 perseverance
 nt: manuals

information management
 scope: the understanding of and manipulation of data
 rt: domain specific knowledge
 nt: data bases
 data type
 classification
 evaluation
 measurement
 planning

bt: broader term rt: related term nt: narrower term

summarizing
organization
terminology
transfer
unit of analysis

integrated packages
scope: software that includes several types of applications
nt: data bases
spreadsheets
word processing

keyboarding
scope: knowing the location and understanding the use of keys on the keyboard
nt: typing
special keys

logistics
scope: number, type, location and availability of hardware and software
bt: organizational or administrative issues
rt: compatibility

measurement
scope: choice of the appropriate unit for measuring a variable or describing a characteristic and understanding the concept of the unit of measurement
bt: domain specific knowledge
information management
rt: organization

manuals
scope: documentation
bt: help

memory [this is not the right word, it is only part of the idea]
bt: computer concepts
computer literacy
rt: file management

"mindset"
scope: attitudes towards the computer and towards ways of approaching problems [is there a better term for this?]
bt: "mindware"
nt: applications
experimentation
perseverance
enthusiasm

bt: broader term rt: related term nt: narrower term

"mindware"
 scope: cognitive styles and problem solving strategies and attitudes
 nt: applications
 experimentation
 "mindset"
 perseverance

modes
 bt: computer concepts
 rt: editing

organization
 scope: outlining or structuring and breaking down the whole into
 parts and choosing variables
 bt: information management

PFS
 bt: integrated packages
 word processing
 data bases
 graphs and graphing

planning
 scope: setting up or designing a file, a text, a spreadsheet, or
 a program
 bt: information management
 rt: organization

process/product
 scope: a focus on the steps involved in carrying through a task or
 solving a problem, as opposed to the focus on a solution or final
 product [is this a target of difficulty, or another way to describe
 teachers' analysis?]
 bt: mindset
 rt: evaluation
 organization

Quill
 bt: integrated package
 word processing
 data bases

screen focus
 scope: awareness and attention to the interactive nature of the
 screen/computer
 bt: computer concepts
 rt: cursor

bt: broader term rt: related term nt: narrower term

search strategies
 bt: information management
 data bases
 rt: classification

sequence
 scope: the concept that one action or idea should precede another or the skill involved in ordering information
 bt: computer concepts
 organization
 keyboarding
 rt: cursor
 editing
 modes
 typing
 screen focus
 special keys

special keys
 scope: those keys which perform operations rather than printing a symbol
 bt: keyboarding
 rt: typing
 cursor

spreadsheets
 nt: Appleworks
 Visicalc

summarizing
 scope: involves reducing information without loosing relevant pieces
 rt: organization

terminology
 scope: the understanding specific vocabulary within a context and the choice of the most appropriate word to describe or label any information from a data base to a variable. (Should this have 'naming' as a narrower term? Chip, yes; Joan, no)
 bt: information management
 unit of analysis
 rt: classification
 search strategies
 organization

transfer
 scope: utilizing information learned in one area in a new area

bt: broader term rt: related term nt: narrower term

typing
 bt: keyboarding
 rt: special keys

unit of analysis
 scope: subject to be studied or unit of analysis
 bt: information management

Visicalc
 bt: spreadsheets

word processing
 bt: integrated packages
 nt: editing

Appendix C

Sample Data Base of Difficulties
Arranged in Outline Format

Introduction: The examples given in the outline below were taken from our observations of teachers learning to use applications programs during a summer workshop and our interviews with teachers. They are just a sampling of the difficulties we found in our data, although we have tried to list as many different problems as we encountered. With a few exceptions, we have only given one example for each problem that we listed.

The terms used in this outline are described and defined in the preceding Thesaurus. As we noted there, the list is a constantly changing one; please make any suggestions that will make the list more accurate, precise, consistent and/or elegant. Many terms represent compromises that none of us like, but we haven't been able to think of a better one. A major problem is reconciling the differences in the terminology of teachers and that of researchers and that of both with terminology of those working with computers, a field in which the vocabulary is still evolving.

1. Difficulties inherent in the use of computers

1.1. Keyboarding

1.1.1. Typing -- location of characters on the keyboard
Example: "The first part of doing word processing is painful. It's like having your teeth pulled all at once -- just a half-hour turn and turn out three sentences. At the end of the year, they're banging away." [Interview 3rd grade teacher]

"The only person who chose not to [learn touch typing] ... would go down there [computer lab] to create and his creative endeavor would be frustrated, because he couldn't find the letters to type what he needed." [Interview, 4th grade teacher]

1.1.2. Special keys -- Multiple/simultaneous keystrokes
Example: Applewriter II: Teacher presses, but did not hold down the "Control" key while typing letter, resulting in the letter being printed, not a function performed.

"There are a lot of commands. I put charts up on the wall, but I think there's a lot to remember for kids, which keys move the cursor, using Control-P, to print and the NP, those sorts of things, especially for the slower kids." [Interview, junior high computer teacher]

1.2. Computer concepts -- Basic conceptual difficulties

1.2.1. Cursor -- Understanding the significance of the cursor
Example: Visicalc: Teacher does not move cursor to desired location for entering the result of a computation; the result appears in a column of data.

1.2.2. Editing -- Knowing that it is possible to edit

1.2.3. File management -- Knowing that files can/should/need to be loaded or saved
Example: "The whole buffer ... file kind of notion with word processors, developmentally some kids -- third graders aren't ready for it. [Interview, 3rd grade teacher]

1.2.4. Modes -- Knowing about modes
Example: "they had no trouble with modes at all -- except for one child who wasn't familiar with the keyboard." [Interview, 4th grade teacher]

1.2.5. Sequence -- Knowing about the order of operations

1.2.6. Computer literacy -- Knowing that software and hardware have abilities and limits

1.2.7. Compatibility

1.2.8. Screen focus -- Attending to the interactive nature of the screen
Example: Visicalc: The teacher the put cursor on character she was trying to delete and repeatedly pressed the delete key. She saw no change in the text on the screen, because she was looking at the figure the cursor was on, rather than the one to the left of the cursor.

1.2.9. Format

1.2.10. Help
Example: "if you make a mistake in ... you get "syntax error"; you can't tell from that what you are doing." [Interview, 4th grade teacher]

1.2.11. Memory
Example: "Some kids, slower kids, had some difficulty with [the difference between having a file that exists only in memory and a file that exists on disk]. For instance, I have printers attached to only two machines, so if they were working at another machine, they had to save their material on a disk and then carry the disk over and they would immediately turn on the printer and think that as long as the disk was in the drive, that the material on it would be printed. And they didn't understand that they had to load the material from the disk on the computer, and then print it." [Interview, junior high computer teacher]

1.2.12. Data type
Example: When using PFS File, a teacher entered "20-25" for her class size.

1.2.13. Manuals

1.2.14. Special keys -- understanding that keys can perform functions other than printing letters or numbers.
Example: Applewriter II: Teacher repeatedly presses the enter key or carriage return at the end of a line, rather than allowing wordwrap to operate.

1.2.15. Transfer --

1.3. Difficulties with operations within specific programs

1.3.1. Moving the cursor
Example: Applewriter II: Teacher tries to use the up and down arrows to move the cursor; since this version of Applewriter II only used the left and right arrows, the cursor did not move. [observation]

1.3.2. Editing
Example: Applewriter II: Teacher puts 24,000 blank spaces at the end of the text and is unable to add more characters.- [observation]

Visicalc: Teacher can not change the column entry. [observation]

1.3.3. Changing modes
Example: Applewriter II: Teacher asks how to get into the edit mode. [observation]

1.3.4. File management -- loading and saving files
Example: Visicalc: Teacher loads Applewriter text file instead of Visicalc data file. [observation]

1.3.5. Sequence -- following the correct order of commands or operations

Example: PFS: Teacher is trying to design a form, but instead types in the data before finishing the form design. - [observation]

1.3.6. Computer literacy -- understanding the limits and capabilities of the program

Example: Visicalc: Teacher tries to use a predefined key (=) as a column entry and gets a bleep and no entry. [observation]

1.3.7. Compatibility -- knowing how to interface this software or hardware with other software or hardware

Example: "But to juggle graphing and spreadsheets and word processing with PFS File is very complex ... You even have to go to a different saving system." [Interview, high school computer teacher]

1.3.8. Screen focus -- attending to the prompts and messages on the screen

Example: Applewriter II: Teacher deletes a word using "Control W" when intending to insert a word. Teacher failed to notice that the insert/delete arrow was pointing in the wrong direction. [observation]

Visicalc: Teacher fails to see the word "label" that appears in the data line in response to pressing " (quotation mark); Teacher continues to press ". [observation]

1.3.9. Format -- knowing how to place the text on screen and page

Example: "[the Apple] II+'s only have a forty column display and yet, you get a 80 column print." [Interview, junior high computer teacher]

1.3.10. Help -- being able to get help within the program

1.3.11. Memory

1.3.12. Manuals

Example: "I think the manuals are not designed for kids. I have rewritten my own Applewriter manual for kids with large print, one concept on a page, and they're in chart form." [Interview, junior high computer teacher]

1.3.14. Special keys

Example: PFS: Teacher tries to use "Return" instead of "Control C'" to enter data. [observation]

2. Information management -- Difficulties inherent in understanding and manipulating data

2.1. Setting up data bases, spreadsheets, and/or graphs

2.1.1. Deciding on units of analysis
Example: PFS: When creating a form, teacher has difficulty understanding the difference between the form and the data. [observation]

2.1.2. Planning
Example: "When we started doing the [unit] on South America [using PFS File] we first had to identify what information we would need; and part of that was a little difficult, because the kids don't know in the unit what kinds of questions are coming." [Interview, 5th grade teacher]

2.1.3. Classification -- choosing variables
Example: PFS: In entering data onto a PFS form, teacher has difficulty knowing what data are called for by each category: "name" and "address" are clear, but "curriculum needs" is not. [observation]

2.1.4. Data types

2.1.5. Measurement -- Choosing units of measure
Example: PFS: Entering data onto form, Teacher #1 uses time measures, whereas Teacher #2 uses type indicators for the same variable. [This was not viewed as a problem by the teachers, other than that "when we go to retrieve our data, it will be real hard, because we filled out our forms so differently."] [observation]

"when we got to graphing ... Three of the countries would up at the top of the graph. All we know is that they are more than ... How can we bring that down so we can get it?" [Interview, 5th grade teacher]

2.1.6. Organization

2.1.7. Terminology -- Documenting/labeling: This includes both understanding that a data base, unit of analysis, variable, or unit of measure may be called by different labels and choosing vocabulary appropriate to those who set it up and those who use it.
Example: One kid put down for climate "hot"; another kid put down "very warm" and other kids were putting other kinds of things that all meant the same sort of thing. What they didn't realize in the beginning, because they hadn't had to search on this kind of thing ... They didn't realize that they wouldn't be able to pull out the information they needed.

It wouldn't be in a consistent way." [Interview, elementary computer specialist]

2.1.8. Summarizing

2.1.9. Transfer

2.1.10. Evaluation

Example: "We had to question information that we got from various resources: we found -- we thought we were looking at two 1984 atlases, but one was using a 1980 census, and another one was using something a little more up-to-date: we didn't know what that was. We had to translate that: we had to back, [up], because we couldn't get enough information on them both. We were talking about different populations. - [Interview, 5th grade teacher]

"a lot of lower-level kids [high school students] think that when you correct papers what you do is you make it neater. And since it already is neat, you don't have to do as much correcting ... They'll do something in all caps -- all caps. And it won't phase them at all. Or they'll do something and everything's indented; but it looks so good! So they don't change it" [Interview, high school computer teacher]

2.1.11. Domain specific knowledge

Example: "they didn't really know what 'temperate' was." - [Interview, 5th grade teacher]

"I do [get into averages and derived columns in Visicalc], but I only do it with those kids that need to use it. Some of these kids ... don't know whether you multiply or subtract or divide to get an average. And work with variables is tough." [Interview, high school computer teacher]

2.2. Search strategies and use of data bases, spreadsheets and graphs

2.2.1. Choosing units of analysis

2.2.2. Planning

2.2.3. Organization

2.2.4. Classification -- Choosing variables

2.2.5. Data types

2.2.6. Terminology -- Documenting/labeling/: This includes both the understanding that different documents may use different labels

or vocabulary for the same information and finding the appropriate ones.

2.2.7. Searching -- Understanding the different ways of searching a data base, e.g. hierarchical searches and relational searches

2.2.9. Help

2.2.10. Summarizing

2.2.11. Transfer --

2.2.12. Evaluation

2.2.13. Domain specific knowledge

3. "Mindware" -- Cognitive strategies and attitudes

3.1.1. "Mindset" -- attitudes towards the computer
Example: "I started out ... as one of those people that maybe would peek through the door when the computer was turned on. I found them incredibly intimidating." [Interview, 4th grade teacher]

3.1.2. Application -- Seeing how a tool can be used
Example: "One of the hardest, the hardest thing to do using tools, for me, is to get the kid to identify a problem that is worthwhile. Because the kids will learn the tools ... and then I'll say, 'Now go find a problem.', and they'll say, 'What's a problem? What are you talking about? We're done here, we've learned this. We want to do something else now.'" [Interview, high school computer teacher]

3.1.3. Experimentation -- Willingness to try different ways of solving problems and/or understanding that we learn by our mistakes

3.1.4. Enthusiasm -- Orientation to computers

3.1.5. Organization -- [This concept needs to be redefined.]
Example: "I think the most difficulty children have is not at the keyboard, managing the software, but organizing themselves to the the information. I saw that both first in the simple little base and in the South American unit: just making sure that before they sat down at the computer they had all of the information they needed so they weren't having to run off at all for, 'Oh, I didn't get that birthdate', or 'I'm not sure how to spell that person's name.'" [Interview, elementary computer specialist]

3.1.6. Perseverance

3.1.7. Process/product orientation -- a focus on one or other

4.0. Organizational support

4.1. Logistics

Examples: Unless they have access, some of my kids by the end of the year, they would say, 'Hey, I don't care if I write on the computer or write in my notebook.' It tended to be girls with good penmanship writing with a pencil and they want to write the story. They don't want to wait two days until they get a turn on the machine, if they want to use it." [Interview, 3rd grade teacher]

"One of the biggest problems in using the computers in the framework of this school is just finding the time to use them and having the materials properly returned. So that when it's your half-hour, and you are signed up, the Bank Street Writer disk is back in the folder and your kids just go down and get it without having to run around the school... I think that personal reliability of the individual is the biggest deterrent to having a shared computer lab, and especially having the software shared ... I think that is the biggest frustration. ... All the aggravations that shouldn't exist, that do: sharing is hard." [Interview, 4th grade teacher]